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What Can We Learn from EU ETS?

In this paper we provide some context behind the EU's effort to implement EU-wide carbon pricing through EU ETS. Next, we discuss several lessons that could be drawn from this experience. Note that our focus is on EU ETS as the main vehicle for carbon pricing; other climate policies, including performance standards and subsidies for investment and innovation, remain largely untouched.

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IMPLEMENTING EU GHG EMISSIONS REDUCTION TARGETS THROUGH EU ETS

As agreed in Paris in 2015, countries should aim together to curb greenhouse gas (GHG) emissions to keep a global rise in temperature well below 2 degrees Celsius (United Nations 2015). This requires a very deep cut in GHG emissions as current levels would make a 3 degree rise in temperature in 2050 very likely. Carbon pricing is widely considered to be a crucial tool in reaching targets for deep decarbonization. Indeed, pricing ensures emission reductions at the lowest cost to society by offering flexibility in the choice of abatement measures and their timing.

Interestingly, GHG mitigation seems to be rather successful within the EU while the EU is also a pioneer in carbon pricing around the world. The EU (including the UK) shows an overall decrease of 21 percent in GHG emissions from 1990 levels by 2013. After an initial decline in the early 1990s, the reductions were largely attained in the aftermath of the economic crisis in 2008. Since 2014, GHG emissions have stabilized again. Nevertheless, the reduction reflects a breakthrough compared with the past, where economic growth correlates strongly with higher energy use and GHG emissions. Indeed, the GHG intensity of GDP fell by even more than 50 percent between 1990 and 2017.

A key instrument applied by the EU has been its explicit carbon pricing policy through carbon allowance trading within the EU Emissions Trading System (EU ETS) since 2005. This system covers around 40 percent of the EU's total GHG emissions and includes three European countries outside the EU. EU ETS is a typical cap-and-trade system inspired by the practical success of the US SO_2 cap-and-trade scheme in the 1990s (Burtraw and Szambelan 2009). Its main purpose is to reduce GHG emissions in a cost-effective way by providing a clear reduction pathway for industrial GHGs and to allow individual trades in carbon allowances between firms to find the cheapest abatement options.

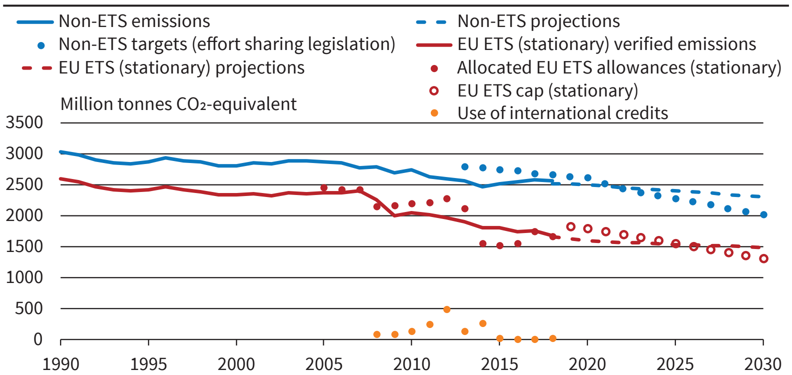
CARBON PRICING THROUGH EU ETS

A carbon cap-and-trade program like EU ETS internalizes the social costs of GHG emissions into (energy) market prices, which would also promote further investments in low-carbon technologies. EU ETS started with a "learning phase" from 2005 to 2007 and its design has evolved over the subsequent trading phases (2008–2012, 2013–2020, and 2021–2030). To date, EU ETS is the largest emissions trading scheme in the world (World Bank, 2019).

Figure 1 provides a concise picture of some key performance indicators for EU ETS emissions in the past as well as into the future. The figure shows a remarkably stable trend in emissions up to a strong decline in GHG emissions due to the economic crisis in the years 2008–2009. After the crisis, emissions never returned to their previous levels and decreased by an average 2.5 percent per year. The figure also shows an important gap between actual emissions and the allowance cap. Because of oversupply during the period 2009–2013, the allowance market built up a huge "bank" of allowances, i.e. allowances that are issued in earlier years but are unused and remain valid in later years as they have an infinite lifetime. Note that in 2013–2014 the bank exceeded a whole year of allowance supply.

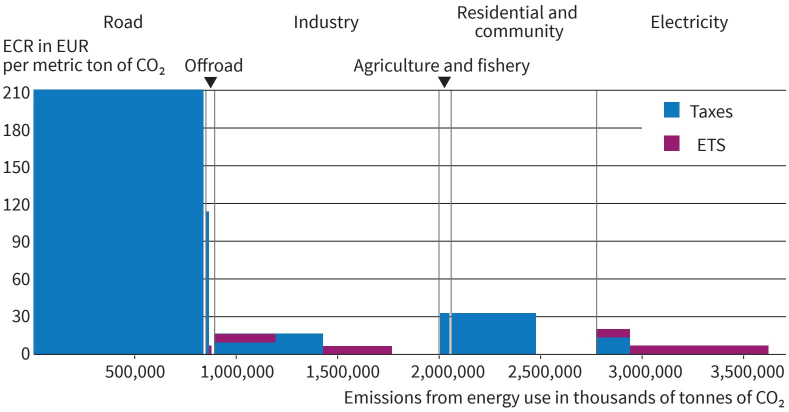
The decreasing cap (the dotted red line in Figure 1) reflects the ambition of the EU to reduce GHG emissions in the ETS sectors to zero in the

Figure 1
GHG Emisions in the EU28



Notes: Emissions from land use, land-use change, and forestry (LULUCF) and from international bunker fuels are excluded. Pre-2005 trends for EU ETS and non-ETS emissions are based on an allocation of 1990–2004 GHG inventory data to either the EU ETS or non-ETS sectors at source category level. EU ETS (stationary) emissions for the period 2005–2018 reflect verified emissions under EU ETS; emissions for the period 2005–2012 were estimated to reflect the current scope (2013–2020) of EU ETS.
Source: EEA (2019).

Figure 2
Carbon Pricing of CO_2
Emissions by sector and component, 2015



Note: Both tax base and rates are based on actual country-specific energy taxes.
Source: OECD.

longer run. With the linear reduction factor as adopted in the revised EU ETS Directive of 2018, the supply of allowances will be zero in 2057. The decreasing cap implies that the cap will become more and more restrictive. The bank only helps to smooth the impact as it provides for intertemporal flexibility.

Figure 1 also illustrates the performance of EU ETS relative to the so-called non-ETS sectors. Various policy instruments contributed to a decline in emissions from these sectors, such as energy taxes, emission standards, and subsidies for energy efficiency improvements. However, this decline is less pronounced compared to EU ETS and even turned into a rise of emissions since 2014. Indeed, according to projections, additional reductions will be required in the 2020s. The flexibility mechanisms under the Effort Sharing legislation allow member states to sell part of their emission allocation for a certain year to another member state. Indeed, some member states, like Germany, are expected not to meet their non-ETS targets up to 2020 and will have to buy emission allocations from countries that have reduced emissions more than required.

Finally, the relevance of EU ETS for carbon pricing within the EU can be illustrated using effective carbon rates (OECD 2018). Using a highly disaggregated database of energy use and implicit carbon taxes as well as cap-and-trade information, the OECD presents a concise evaluation of how well the carbon emission base is priced (Harding et al. 2014). The analysis presents the rates on (fossil fuel) energy use in terms of carbon emissions. These effective rates do explicitly account for actual carbon taxes, specific taxes on energy use, and tradable emission permit prices in the various countries and consider the share of emissions priced at various levels. Emissions for which tax rates are zero are also included in the calculation. Figure 2 presents this graph for the whole of the EU.

According to this analysis, EU ETS prices most, though not all, carbon emissions in the power sector and about 60 percent of those in industry. EU average tax rates for road transport and in the residential sector, recalculated based upon their underlying carbon intensities, are generally much higher.[1] These higher rates, in particular the mineral oil products gasoline and diesel used in the transport sectors, should also be linked to other externalities, however, such as air quality impacts (Parry and Vollebergh 2017).

FIRST LESSON: THE CAP

After the “learning by doing” pilot of the first trading phase (2005–2007), a key step in setting a cap for the EU has been the gradual change from national allocation plans to a common overall approach where EU legislation guarantees the cap to be reduced annually by roughly 38 million allowances in the third trading phase (2013–2020). This corresponds to a so-called linear reduction factor (LRF) of 1.74 percent of the average total quantity of allowances within the EU. This factor has even been further increased to an LRF of 2.2 percent in 2018, which would guarantee zero additional carbon allowances in 2057.

Setting the level of the cap and its development over time is by far the most important element of cap-and-trade policies. The cap limits the overall quantity of emissions and therefore guarantees – like (enforced) standards – the effectiveness of the environmental policy. To what extent this trajectory fits optimal climate policy, however, cannot easily be derived from a simple cost-benefit evaluation of climate policy. Good reasons exist to evaluate the trajectory against policy goals as agreed upon internationally, such as the Paris agreement of 2015 (see e.g., Heal and Milner 2014).

A very important step forward has been the change from a fixed to a flexible duration of the value of an allowance starting from the second trading phase onwards. Consequently, firms were able to bank their allowances for use in subsequent trading periods. A look at Figure 1 shows that demand for allowances throughout the second period was below

[1] Note that the figure reflects the relatively low rate for the EU ETS in 2015. ETS prices have increased significantly since 2018 (see also Figure 3).

the allocated allowances and a very large bank of allowances built up. The bank is almost equal to the total supply of allowances in 2018 and allows for intertemporal flexibility at the carbon allowance market but does not change the overall amount of emissions that are capped during the entire period in which the policy is effective.

A related issue has been the allowance of "offsets," i.e., the option to allow additional emissions if they could be offset through international credits provided by the Clean Development Mechanism (CDM) and Joint Implementation (JI). This way, credits for more than 1 billion metric tons of CO_2 equivalents have been surrendered in phase 2, which has been an additional factor explaining the overallocation and therefore the growing lack of scarcity during the second period (see also Verdonk et al. 2013). Moreover, the contribution of CDM projects to actual emission reduction is challenged as well (Ellerman et al. 2015). Although offsets can be an important tool to provide flexibility for outside options, such as low-cost abatement projects, their use should be carefully managed, as the impact of CDM has shown.

The first important lesson is that a cap-and-trade system like EU ETS is very helpful in guaranteeing a credible and binding reduction of emissions within the ETS sectors. The gradual yearly reduction of allowances is a key element to deliver its promised contribution to a long-run deep decarbonization within EU ETS, whereas no such guarantee would be provided by using a carbon tax instead. Trust in the system is essential and the fact that EU ETS is firmly established in European law is very helpful and guarantees its participants the rule of law. Further ambitions, such as expressed by the European Green Deal, are best implemented by increasing the LRF. Also, prudence in using offsets is essential as the experience within EU ETS has not been convincing.

Figure 3
Futures Prices EU ETS Allowances

Notes: Non-adjusted Euro price based on spot-month continuous contract calculations.
Source: ICE (ECX EUA Futures prices, Continuous Contract #1).

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SECOND LESSON: TRADE

The second key element of any cap-and-trade system is the option for individual firms to trade. In other words, with enough scarcity in the market, trades will occur between those who have a surplus of allowances and those who are in actual need for compliance at a given point in time. Indeed, the overall supply determines the number of allowances becoming available for trade, but trading between market participants occurs only if buyers need allowances for short-run compliance or long-run hedging. Indeed, trade has been much easier since the change that meant allowances remain valid indefinitely. Banking strongly increases market liquidity as this allows for the possibility to trade against future expected emissions and firms can individually optimize compliance over their entire planning horizon (Ellerman et al. 2015).

For almost the entire phase 2, EU ETS has suffered from a lack of scarcity, however. In addition to the economic crisis in 2008–2009 and the use of international credits, the impact of renewables and energy efficiency policies also played a role here (Koch et al. 2014). Both energy efficiency improvements and an increased share of renewable energy reduce demand for allowances because energy use and the generation of electricity were mainly fossil fuel based. National policies supporting the deployment of renewable energy technologies in the EU have also been an important driver of emission reductions in the EU ETS sector electricity (Van den Bergh et al. 2013).

Due to this relative lack of scarcity in the carbon market in phase 2, prices were rather low for a very long time (see Figure 3). This collapse of the carbon price ignited a heated debate to neutralize the lack of scarcity in the market (see also Ellerman et al. 2016). In particular, support grew for the idea of introducing a minimum price or even a price collar within EU ETS (e.g. Burtraw et al. 2010). Policymakers in the EU followed another approach by setting up quantity-based interventions, such as backloading and the so-called Market Stability Reserve (MSR) agreed upon in 2018.

The idea behind the MSR can be summarized as a quantity-based rule: if the total number of allowances in circulation is

– less than 400 million in a year, then the MSR releases 100m allowances into circulation in the following year;
– between 400 million and 833 million, then the market functions without any release or absorption;

– greater than 833 million, then the MSR will reduce the volume of allowances auctioned in the subsequent year by 12 percent of allowances in circulation (note that during the first years of operation, i.e., 2019–2023, the absorption rate will be 24 percent).

The core impact of the MSR is its governance of the excess quantity in the bank of allowances. This feature will reduce the overall supply of allowances by a substantial amount if the bank gets "too large."

The MSR reform invoked a heated debate among economists about its impact and effectiveness. Some argue that the MSR's core feature would make the EU ETS emissions cap a function of market outcomes (Perino et al. 2019). Others suggest that the MSR would inevitably lead to a new Green Paradox and increase total emissions (Gerlagh et al. 2019). To what extent the MSR quantity-based mechanism will have an impact on the overall amount of allowances is not easy to judge, however. One should be very careful when deciding against what counterfactual to evaluate its impact.

As shown by Perino et al. (2019), the supposed impact of the MSR rules depends on the points in time when the MSR is predicted to become effective and stops taking in allowances when the bank is depleted "enough." Demand for allowances, however, is notoriously difficult to predict. Not only do uncertain macroeconomic developments have an impact, but also overlapping policies and assumptions on the carbon abatement cost in the future. It should not come as a surprise that estimates for allowance cancellations in the literature range from 2 billion to 16 billion allowances (Perino and Willner 2017; Bruninx et al. 2019).

Whatever the outcome of the debate, the MSR reform has already had an impact on the carbon price in practice. Since the MSR together with the stricter LRF were implemented into European law in 2018, allowance prices have surged up to EUR 25 on average in 2019 (see Figure 3). This suggests that the market expects future scarcity to increase, which casts its shadow through this price hike. Such an impact would have been unlikely if the market believed that these measures would be ineffective. In other words, the impact of the new MSR rules is relevant but should also not be exaggerated. Moreover, the rules of the MSR itself are subject to updating because the MSR will be reviewed in five-year intervals.

The lesson on trade is that providing enough flexibility in a cap-and-trade system is essential but should also be guided with care. Intertemporal trade is key to a well-functioning market but might also lead to low prices if allowances are abundant. Additional measures in such circumstances are unavoidable for the system to remain a credible instrument for carbon pricing and to have impact on current market and future investment decisions. We believe that for newly introduced cap-and-trade systems, some degree of hybridity is essential, either through a price collar or quantity rules such as the rules in the MSR. Both mechanisms help to steer cap-and-trade programs in the event of unexpected shocks and unanticipated overlapping policies, although a price collar has the advantage of more transparency.

THIRD LESSON: COVERAGE WITHIN THE OVERALL CLIMATE PRICING POLICY APPROACH

Figure 2 illustrates that EU ETS is an important cross-cutting tool for pricing carbon from the use of fossil fuels within the EU. Its carbon price "base" covers most emissions within the electricity sector and in energy-intensive industry. Indeed, the idea was originally to limit EU ETS to large combustion installations only, such as installations with a total rated thermal input exceeding 20 MW. Including smaller installations would become too costly in terms of transaction cost and taxes on mineral oils already account for the implicit pricing of carbon in the so-called non-ETS sectors (see also Vollebergh et al. 1997).

This hybrid approach towards using two different policy instruments for carbon pricing is occasionally challenged. For instance, the European Green Deal of the European Commission argues for including the maritime sector in EU ETS (EC, 2019). Some economists go much further and argue in favor of extending EU ETS to the transport sector (Hepburn and Toytelboym 2017; Creutzig et al. 2010).

The idea of an upstream inclusion of transport fuels into ETS has the benefit of simplicity in providing an EU-wide instrument to guarantee equal carbon abatement costs across the economy. Indeed, carbon emissions are directly linked to the carbon content of transport fuels, mainly mineral oils. Extension would be easy by including upstream refineries and importers of refined fuels into the system.

Extensions make sense for sectors that are not yet subject to any carbon price, such as shipping and, previously, air transport. Although an (implicit) carbon tax on fuel or kerosene would be a good alternative, inclusion in EU ETS certainly improves welfare. Less obvious, however, is to see why such a policy would be preferable if fuels are already subject to an implicit carbon tax.[2]

First, Figure 2 shows that including transport fuels and other sectors in ETS would result in a much larger overlap of existing (implicit) carbon pricing policies. Overlapping instruments may have strong negative impacts on both effectiveness and

[2] The overall welfare impact of such a carbon price reform policy would depend on both incentives and transaction costs, which, in turn, also depend on both upstream and downstream abatement options and cost. Note that the subsequent reasoning does not apply to the inclusion of intra-EU flights in EU ETS since 2012, as kerosene was largely unpriced.

efficiency. Using an applied CGE model, Brink et al. (2016) show how (additional) EU carbon taxes simply crowd out the cap-and-trade policy if the two policies interact on the same carbon emission base.

Second, if the emissions trading system for the transport sector will replace existing fuel taxes, most likely the carbon price of fuel use will decrease, as current fuel taxes are much higher than the price of EU ETS allowances. Given the relatively high marginal cost of reducing emissions in the transport sector, it will be more attractive to buy allowances than to reduce emissions. This would shift abatement from the transport sector to other sectors covered by EU ETS, increasing fuel use and making electrification of cars more difficult.

Third, such a switch would also increase local air pollution. Extending EU ETS to road transport would make the ETD redundant from a carbon policy perspective. However, fuel taxes cannot be removed totally, as member states still use their fuel taxes for other transport-related externalities such as air pollution and congestion (Parry and Vollebergh 2017).

One could wonder why the current boundaries of carbon emissions associated with large combustion within EU ETS should in any case be changed. The tendency in several non-ETS sectors is towards electrification, such as electric cars or the use of (electric) heat pumps. This development is the result of targeted policies in those sectors, such as the gradual rise in stringency in the EU-wide fuel standards for car companies. Moreover, expanding electrification will shift demand away from mineral oils to electricity, which is already covered by EU ETS.

The lesson on coverage of sectors is that the choice to focus on large installations makes a lot of sense from an overall welfare perspective. It is far from obvious why EU ETS should cover the entire carbon emissions base. Including small-scale installations and other hard-to-monitor individual emitters might simply be too costly if other instruments, like (implicit) carbon taxes and standards, are already available. This argument holds even if potential upstream options, such as the inclusion of implicit emissions through refinery products, are available.

FOURTH LESSON: IMPACT ON CARBON EMISSIONS, LEAKAGE, AND INCREASED EFFORTS

The EU ETS cap guarantees reductions in carbon emissions in the long run as it settles a carbon budget within the EU over time. This budget is enforceable as long as the system is kept intact, even though its flexibility allows actual carbon emissions to be different from the annual emissions cap in a specific year. Indeed, the overall trend in carbon emissions within the EU over the last decade is decreasing, as Figure 1 demonstrates. This overall downward trend follows from the decreasing emissions trend within the EU ETS sectors, in particular the electricity sector.

It is still unclear to what extent EU ETS has contributed to this downward trend. In particular, the increased deployment of renewable energy technologies boosted by national policies, often in the form of feed-in tariffs and premiums, has likely been the primary driver in emission reductions in this sector. However, EU ETS also increased the cost of carbon-intensive production and it may have contributed by encouraging short-run fuel switching from coal to natural gas (Delarue et al. 2010) and by changing long-run expectations of returns on investments in carbon-intensive projects.[3] Dechezleprêtre et al. (2018) find evidence for carbon emission reductions through EU ETS in the order of − 10 percent between 2005 and 2012 by comparing installations whose production capacity is above the inclusion threshold (and therefore became regulated by EU ETS) with those that are below the threshold but are otherwise similar. In addition, Calel and Dechezleprêtre (2016) show that EU ETS has increased low-carbon innovation among regulated firms.

These trends do not show the potential impact of EU ETS on carbon leakage. Carbon leakage occurs if a reduction in domestic carbon emissions is offset to some extent by increasing emissions in countries where climate mitigation policy is absent or less stringent. According to several studies, such leakage impacts can be substantial (Böhringer et al. 2010; Bollen et al. 2012). Empirical estimates also suggest a gradual shift of carbon gravity towards countries like China and South Korea (Aichele and Felbermayr 2012). Although developed countries have reduced their territorial emissions, this effect is at least partially offset by importing embodied carbon (UNEP 2019). Such carbon leakage poses a serious threat to uncoordinated climate policies, not only in the EU but also in other developed countries.

Leakage issues become even more pressing if one looks at recent EU efforts to align its efforts with the ambitions of the Paris agreement. The imposition of stricter measures on EU carbon emissions to aim at worldwide net zero carbon emissions in 2050 has recently received a boost by the EU initiative of a Green Deal. This initiative is strongly supported by a growing number of EU member states who advocate for EU climate policy to be more ambitious, or by a coalition of the willing of intra-EU member states at least.

It is important, though, to understand that despite several efforts to cap worldwide GHG emissions, such as the Kyoto protocol in 1997, overall yearly GHG emissions have doubled since 1990 and the global trend is still upward instead of downward. An exception in this world of growing emissions, however, is the EU. Despite a yearly economic growth

[3] Note also that EU ETS has an impact on the effectiveness of renewables policies: a carbon price reduces the cost difference between fossil-fuel-based electricity and electricity from renewable energy sources (Verdonk et al. 2013).

of 1.8 percent, emissions of GHGs declined annually by 0.9 percent on average between 1990 and 2018. Nevertheless it is still a challenge to continue this trend into the future, as Figure 1 illustrates. Furthermore, even with the increased LRF of 2.2 percent agreed upon in 2018, GHG emissions within EU ETS will still be somewhat higher than the level required for carbon neutrality in 2050 while the EU ETS price is well below the discounted social cost of carbon for 2020 (OECD 2018).[4]

Whatever the initiative for further emissions reductions, any additional measures on top of existing EU policy would benefit strongly from better coordination of international carbon pricing policies or, in the absence of such coordination, by implementing policies such as border price adjustments to prevent a carbon race to the bottom. Such coordination is particularly important for exposed industries such as the manufacturing industry that are part of EU ETS. Currently, the risk of carbon leakage from EU ETS is addressed by free allocation of allowances to industries that are vulnerable to competition from outside the EU. And some member states compensate companies for the increase in electricity costs due to EU ETS.

The lesson here is that carbon pricing through EU ETS has contributed to the clear downward trend in carbon emissions within the EU, although subsidies for cleaner electricity generation have played a large role as well. However, we also observe a gradual tendency to outsource emissions to other regions, which consequently increases the carbon footprint of our consumption. With further initiatives to increase stringency ahead, it is a logical next step to invest more resources in a carbon border adjustment mechanism for selected sectors to ensure that the price of imports will more accurately reflect their carbon content and to reduce the risk of carbon leakage.

CONCLUSION

The EU is aiming for climate neutrality by 2050. For this purpose, stricter carbon pricing policies seem to be key. With its clear reduction pathway for CO_2 emissions up to 2030 and beyond, EU ETS provides firms a clear and credible incentive to reduce emissions. Indeed, EU ETS is the only instrument currently implemented within the EU framework on climate and energy policy that imposes a hard limit on carbon emissions and guarantees the application of a carbon emissions budget. While allowing participants to also trade their allowances, however the system also provides a cost-efficient way of reducing GHGs from a variety of large sources.

Empirical studies confirm that EU ETS contributed to emission reductions as well as innovation in low-carbon technologies even when the carbon price was relatively modest. After years of relatively low allowance prices, however, the recent revision of the EU ETS directive contributed to an unprecedented price rise, with the price also likely to rise even further in the future due to the decreasing cap. Higher carbon prices will further promote investments in technologies that are required for the EU to achieve its long-term target of a low-carbon society by 2050.

Extending coverage of EU ETS to current non-ETS sectors such as transport or buildings is a less obvious step for us. Most of fossil fuel-based heating and motor fuels will gradually give way to electricity. If this electricity is generated by fossil fuel-fired power plants, the associated emissions will be covered by EU ETS, and otherwise the impact on carbon emissions is clearly positive. Instead of focusing on the extension of EU ETS towards non-ETS sectors, efficient carbon policies seem to benefit much more from efforts to align existing implicit carbon taxes with the broad set of externalities relevant for these combustion processes.

[4] In its recent study the OECD also includes a price reference rate to explore so-called carbon pricing gaps (OECD 2018). The carbon pricing gap not only includes price base gaps but also takes into account an estimated social cost of carbon.

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